Fish & Wildlife Division

WILDLIFE CONSERVATION AND BIODIVERSITY SECTION

# Status of the Western Silvery Minnow (*Hybognathus argyritis*) in Alberta

**Alberta Wildlife Status Report No. 47**

Alberta Conservation Association

Alberta
SUSTAINABLE RESOURCE DEVELOPMENT

103-06041/

# Status of the Western Silvery Minnow (*Hybognathus argyritis*) in Alberta

Prepared for:
**Alberta Sustainable Resource Development (SRD)**
**Alberta Conservation Association (ACA)**

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*This report has been reviewed, revised, and edited prior to publication.*
*It is an SRD/ACA working document that will be revised and updated periodically.*

**Alberta Wildlife Status Report No. 47**

**January 2003**

**Published By:**

Alberta
SUSTAINABLE RESOURCE DEVELOPMENT

Alberta Conservation Association

Publication No. T/032
ISBN: 0-7785-2328-4 (Printed Edition)
ISBN: 0-7785-2329-2 (On-line Edition)
ISSN: 1206-4912 (Printed Edition)
ISSN: 1499-4682 (On-line Edition)

Series Editors: Sue Peters and Robin Gutsell
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Maps: Jane Bailey

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This publication may be cited as:

Alberta Sustainable Resource Development. 2003. Status of the Western Silvery Minnow (*Hybognathus argyritis*) in Alberta. Alberta Sustainable Resource Development, Fish and Wildlife Division, and Alberta Conservation Association, Wildlife Status Report No. 47, Edmonton, AB. 24 pp.

## PREFACE

Every five years, the Fish and Wildlife Division of Alberta Sustainable Resource Development reviews the status of wildlife species in Alberta. These overviews, which have been conducted in 1991, 1996 and 2000, assign individual species "ranks" that reflect the perceived level of risk to populations that occur in the province. Such designations are determined from extensive consultations with professional and amateur biologists, and from a variety of readily available sources of population data. A primary objective of these reviews is to identify species that may be considered for more detailed status determinations.

The Alberta Wildlife Status Report Series is an extension of the general statusing exercises (1996 *Status of Alberta Wildlife, The General Status of Alberta Wild Species* 2000), and provides comprehensive current summaries of the biological status of selected wildlife species in Alberta. Priority is given to species that are potentially at risk in the province ("At Risk," "May Be At Risk"), that are of uncertain status ("Undetermined"), or those considered to be at risk at a national level by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Reports in this series are published and distributed by the Alberta Conservation Association and the Fish and Wildlife Division of Alberta Sustainable Resource Development. They are intended to provide detailed and up-to-date information which will be useful to resource professionals for managing populations of species and their habitats in the province. The reports are also designed to provide current information which will assist the Alberta Endangered Species Conservation Committee to identify species that may be formally designated as "Endangered" or "Threatened" under Alberta's *Wildlife Act*. To achieve these goals, the reports have been authored and/or reviewed by individuals with unique local expertise in the biology and management of each species.

## EXECUTIVE SUMMARY

The western silvery minnow (*Hybognathus argyritis*) is a small cyprinid fish found in large plains streams of the Missouri and Mississippi river drainages in mid-west North America. Although this species is relatively common in many areas of the United States, it is extremely rare in Alberta, with a confirmed presence only in the lower Milk River. Very little is known regarding the biology of western silvery minnow and much of the information available is based on studies of other silvery minnow species. Abundance of this species in the Milk River does not appear to have changed since it was first identified in Alberta in the 1960s. However, it is suspected that both the extent of distribution and abundance of western silvery minnow within the Milk River may have been altered significantly prior to this time (in the early 1900s), when the St. Mary Canal was constructed to divert irrigation water from the St. Mary River to the Milk River. The combination of water removal for irrigation and extreme drought conditions has probably had the greatest impact on the survival of the western silvery minnow in Alberta. Elsewhere, it is believed that habitat alterations, particularly associated with irrigation, are responsible for declines in the abundance and distribution of western silvery minnow.

The western silvery minnow is currently ranked as "May Be At Risk" according to *The General Status of Alberta Wild Species 2000*. Nationally, it is listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as "Threatened." The extremely limited distribution and low numbers of western silvery minnow consistently encountered in the Milk River make this species extremely vulnerable to extirpation. The combination of severe drought conditions, the operation of the St. Mary Canal, and the removal of water for irrigation left the lower Milk River both above and below the international border completely dry, except for a series of shallow isolated pools, during the fall and winter of 2001/2002. Studies are underway to determine the present status of western silvery minnow in the Alberta portion of the lower Milk River (see Addendum).

## ACKNOWLEDGEMENTS

I wish to acknowledge a number of people for their assistance in compiling information for this document, including Terry Clayton (Sustainable Resource Development, Lethbridge, Alberta), Sean Stash (U.S. Forest Service, Glacier Ranger District, Girdwood, Alaska), Kent Gilge (Montana Fish, Wildlife and Parks, Havre, Montana), Wayne Roberts (Zoology Museum, University of Alberta, Edmonton, Alberta), Dr. Robert Campbell (Species Specialist Subcommittee Co-chair, Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario), Sue Peters (Alberta Conservation Association, Edmonton, Alberta) and Sue Cotterill (Sustainable Resource Development, Edmonton, Alberta). In particular, special thanks go to Terry Clayton for taking the time to show me the key western silvery minnow locations on the Milk River, and providing excellent background information regarding the water and fisheries issues of southern Alberta, as well as a useful review of the manuscript. Thank you also to Mark Steinhilber (Alberta Provincial Museum, Edmonton, Alberta), Sue Peters and Robin Gutsell (Sustainable Resource Development, Edmonton, Alberta) for their useful comments and reviews of the manuscript. Thanks to Jane Bailey (Ducks Unlimited Canada) for creating the distribution maps.

Preparation of this report was funded by the Alberta Conservation Association and the Fish and Wildlife Division of Alberta Sustainable Resource Development.

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## INTRODUCTION

The western silvery minnow (*Hybognathus argyritis* Girard; Girard 1857) is a small fish of the cyprinid (carp) family, native to large plains streams of the Missouri and Mississippi river systems in midwest North America. In Canada, this species' presence has been confirmed in only one river system, the Milk River (Willock 1969a, Scott and Crossman 1973, Nelson and Paetz 1992), which runs east through the grasslands of southern Alberta before joining the Missouri River in Montana. The Milk River is a unique river in Alberta, in that it is the only system in the province that contributes to the Missouri drainage. This attribute of the Milk River explains the very limited range of some fish species in Alberta, including western silvery minnow, which is believed to originate from the Mississippi/Missouri glacial refugium (see Glossary, Appendix 1). In addition to the extremely limited distribution of the western silvery minnow in Alberta, its abundance within the Milk River has remained extremely low since first documented in 1961 (see Appendix 3).

There has been some suggestion that the western silvery minnow was considerably more common before 1917 (Willock 1969b). It was at this time that the irrigation canal from the St. Mary River to the North Milk River was constructed in Montana, resulting in increased turbidity levels. This diversion of water into the North Milk River has also resulted in much greater water volumes during the summer that likely allowed the western silvery minnow greater upstream access into the Alberta portion of the Milk River. However, the combination of water removal for irrigation from the Milk River, temporary or premature canal closures and drought conditions, such as those experienced in 2000-2001, has resulted in extremely low water conditions from summer to late winter. It is this combination of factors that likely limits the abundance and distribution of western silvery minnow in Alberta.

The western silvery minnow is currently considered "May Be At Risk,"* according to *The General Status of Alberta Wild Species 2000* (Alberta Sustainable Resource Development 2001). Nationally, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed western silvery minnow as "Threatened" in 2001. Although this species is considerably more abundant in the Milk River south of the international border in Montana, other states have documented a significant decline or loss of populations. The intent of this status report is to provide a summary of relevant and current information regarding the status of western silvery minnow in Alberta.

## HABITAT

***1. Features.*** - In general, the western silvery minnow is found in backwaters and pools of large, silty plains streams (Pflieger 1980). In Ohio, the western silvery minnow appeared to be most abundant in areas with little or no current, where the water was rich in phytoplankton (small, aquatic plant organisms); and the gravelly, sandy, muddy or debris-covered bottom was not covered in silt (Trautman 1957). Spawning was found to occur only where the rate of bottom siltation was low (Trautman 1957). One early study of a closely related species, eastern silvery minnow (*H. regius*), found that spawners moved to heavily vegetated backwaters in slower-moving reaches of streams (Raney 1939). Rearing of both eastern and western species occurs near quiet inshore areas and tributary mouths where small schools can be found (Raney 1939, RL&L 1987).

The presence and abundance of western silvery minnow in the United States appears to be strongly associated with a number of habitat features including bottom type, gradient and turbidity. The western silvery minnow of the

* See Appendix 1 for definitions of selected status designations.

lower Ohio-upper Mississippi Basin occurs in the Mississippi River proper only below the mouth of the Missouri River (Burr and Page 1986). This section is a transitional area with increased turbidity, increased velocity, shifting sands and silty substrates providing suitable habitat for *H. argyritis* (Burr and Page 1986). These characteristics are also common in the Missouri River, where *H. argyritis* is common to dominant throughout the system (Cross et al. 1986). In particular, the lower Missouri River has extreme fluctuations in water flow throughout the year, high silt loads and unstable streambeds devoid of vegetation (Cross et al. 1986). Similar habitats characterize the lower Milk River in Alberta.

A number of fish species inventories have been conducted on the Milk River in Alberta since the 1960s (Willock 1969b, Clayton and Ash 1980, RL&L 1987, 2001, 2002a, b). These studies all found western silvery minnow limited to the lowest section of the Milk River mainstem, where the river has been described as low-gradient and even-flowing, with many backwater areas and shallow flat and run habitats (see Glossary, Appendix 1). This section of the Milk River is distinct from upstream sections where the habitat features include more runs, riffles and rapids (RL&L 2001). The middle and lower Milk River in Alberta flows through easily eroded shale formations resulting in a soft-bottomed riverbed and muddy, highly turbid waters, in contrast to the more erosion-resistant sandstone formations upstream (Willock 1969b). In addition, the lower section receives less precipitation and waters are considerably warmer (Willock 1969b). Based on the minnow's limited distribution in the lower section of the Milk River, Willock (1969b) concluded that this species was restricted to regions with warm, silty water. Given the lack of other refugia in the lower Milk River, high turbidity provides the main source of cover for the minnow. The western silvery minnow appears to be restricted to mainstem waters in the Milk River, since no individuals were captured in small tributaries in recent studies (RL&L 2001, 2002b); these results support those of an earlier investigation by Willock (1969a). Absence in the tributaries studied may be due to the intermittent nature of the streams surveyed, particularly considering the extreme drought conditions such as those observed during the years 2000-2001.

A microhabitat analysis of the data collected in 2000 and 2001 found that several habitat features for western silvery minnow were similar among the collection sites (RL&L 2002b). These features included relatively low water velocities (0.0-0.03 m/s), low silt depths (0.0-0.10 m), and a high percentage of sand as substrate (95-100%). Similar results were observed for western silvery minnow in the Milk River from the International Boundary Crossing to the Fresno Reservoir in Montana, although the mean velocity was higher (1.5 m/s) (Stash 2001).

The lower Milk River in Alberta appears to contain abundant rearing and feeding habitat for the western silver minnow (RL&L 2001), where, with the exception of fall 2001, quiet waters with low to moderate velocities are usually prevalent (RL&L 2002a). Similarly, overwintering habitat has also been documented in the lower Milk River (Clayton and Ash 1980), although availability is highly dependent on winter flows. Overwintering habitat is likely one of the major limiting factors for the silvery minnow in the Milk River. With regards to spawning habitat requirements, areas rich in aquatic vegetation have been listed as a key feature (Raney 1939, Houston 1998a). However, no aquatic vegetation is present in the lower Milk River. Instead, high waters during the spring result in flooded backwater areas where terrestrial vegetation is often present, particularly near the creek mouths, and spawning minnows may use these areas (T. Clayton, pers. comm.).

***2. Trends.*** - The greatest changes to western silvery minnow habitat in Alberta have been associated with irrigation. In 1917, the St. Mary

Canal was constructed in Montana to divert water from the St. Mary River to the North Milk River for irrigation purposes. In most years, the canal diverts water from April to September, increasing the water volume in the North Milk River and the Milk River proper. Before the construction of the dam, the Milk River was probably a typical small prairie stream, possibly intermittent in times of drought, and generally less turbid (Willock 1969b). The even-flowing waters now observed in the lower Milk River in Alberta were probably mainly restricted to downstream of the international border before the dam was constructed (Willock 1969b). The significant increase in water volume since the canal went into use is believed to have extensively altered the ecological regime of the Milk River (with the exception of the South Milk River fork), by shifting habitat types westward into the Alberta portion (Willock 1969b, T. Clayton, pers. comm.). The result has been the creation of a more turbid, higher-flow system with more potential western silvery minnow habitat available in the lower section of the Milk River in Alberta. However, Willock (1969b) also states that historically, western silvery minnow may actually have used the upper sections of the Milk River before the construction of the canal. The increased flows associated with the canal resulted in greater bank erosion and higher quantities of silt, possibly leading to a rapid decline in the minnow's population size in the upper sections.

Since the construction of the St. Mary Canal, no major losses or changes in habitat have occurred. Rather, the availability of habitat is highly variable from year to year, and mainly dependent on adequate water flows, particularly in the late summer and fall, and for overwintering. During periods of very low flows, the western silvery minnow may experience temporary reductions in available habitat and under extreme conditions, such as those of fall and winter 2001/2002, temporary habitat fragmentation. The extent of the drought during this period was such that the lower section of the Milk River in Alberta, where most silvery minnows have been documented, was reduced to a series of isolated pools, many of which were not deep enough to support overwintering fish (RL&L 2002a). A winter survey of a subset of these pools did not find any minnows present (RL&L 2002a). Furthermore, south of the international border, the Milk River was completely dry to the Fresno Reservoir from September 2001 to February 2002, and the reservoir was only at 4% of its capacity (K. Gilge, pers. comm.).

A small number of western silvery minnows was subsequently collected (July 2002) upstream of the section that was dry in fall 2001 (T. Clayton, pers. comm.). It may also be present in the Fresno Reservoir but has not been confirmed by surveys (K. Gilge, pers. comm.). Therefore, limited re-colonization potential from upstream and downstream sections in the system exists, but the re-establishment of significant numbers in the lower Milk River may require several years. Downstream of the Fresno Reservoir and associated dam in Montana, six more impassible dams upstream of the confluence (see Glossary, Appendix 1) with the Missouri River prevent any broader dispersal of western silvery minnow (Stash 2001, K. Gilge, pers. comm.).

In summary, while rearing and feeding habitat for the western silvery minnow in Alberta appears to be abundant in most years, the availability of overwintering habitat may be quite limited in some years, depending on water flow conditions. In particular, the combination of extreme drought conditions, canal operation and water removal could severely reduce or even eliminate winter refugia for the western silvery minnow in the lower Milk River.

## CONSERVATION BIOLOGY

***1. Species Identification**** - The western silvery minnow is a small fish belonging to the cyprinid

*See glossary in Appendix 1 for definitions of the following terms used in this subsection: total length, fork length, caudal peduncle, and subterminal mouth.

(carp) family (Scott and Crossman 1973). The adult western silvery minnow generally ranges from 75 mm to 125 mm in total length (Pflieger 1980). Until very recently, the maximum fork length recorded in Alberta was 100 mm (Nelson and Paetz 1992). However, studies conducted during 2001 documented fork lengths up to 140 mm (RL&L 2002b). The western silvery minnow is a slender fish with moderate lateral compression and a broad caudal peduncle (Houston 1998a). The snout is blunt with a subterminal mouth, and the eyes are relatively large (Scott and Crossman 1973). Specimens in Alberta tend to be brownish-yellow on the back with silver sides and no obvious lateral band, but dusky spots may occur (Nelson and Paetz 1992). Males in spawning colour are light yellow along the sides and lower fins (Scott and Crossman 1973).

The genus *Hybognathus* contains seven species in North America, three of which are found in Canada (Schmidt 1994). Originally, both the western silvery minnow and eastern silvery minnow (*H. regius*) were considered to be subspecies of the central silvery minnow (*H. nuchalis*) (Scott and Crossman 1973). However, other studies concluded that the three should be considered distinct species based on morphological differences (Pflieger 1971, Hlohowskyj et al. 1989, Schmidt 1994), and this decision was accepted by the American Fisheries Society (Robins et al. 1991).

***2. Life History.*** - In general, very little is known about the life history of the western silvery minnow (Nelson and Paetz 1992). Most information comes from references for other silvery minnow species. The only information available on spawning, fecundity (egg-producing capacity) and early development refers to an early study conducted by Raney (1939) in the Cayuga Lake drainage (New York State) on the eastern silvery minnow. This study found that female eastern silvery minnows likely matured at one year of age (50-55 mm long), whereas males were not thought to spawn until their second year. Spawning was documented in the spring (late April to early May) when temperatures reached 13.0° to 20.5°C (Raney 1939). Spawning of western silvery minnow in Alberta is believed to occur in May, but no evidence has confirmed this time (Scott and Crossman 1973). Prior to spawning, adult eastern silvery minnows were observed moving to well-vegetated lagoons in the lower reaches of lake tributaries or slower-moving areas in larger rivers. These fish laid non-adhesive, demersal eggs (eggs that sink) on the muddy bottom of quiet areas, in water about 0.3 m deep that supported abundant aquatic and shoreline vegetation (Raney 1939). The fecundity of H. regius was found to range from 2000 eggs in a 60-mm female (standard length) to 6600 eggs in a 90-mm female, and egg diameter was approximately 1 mm (Raney 1939). Newly hatched larvae measured 6 mm in total length and began to form schools along the shoreline approximately 2 weeks after hatching (Raney 1939). No information was available regarding longevity of the western silvery minnow.

***3. Diet.*** - Although no information on diet is available for the western silvery minnow, the central silvery minnow is a bottom-oriented feeder found in large schools (Pflieger 1980). Both the central and the eastern silvery minnow species ingest bottom detritus and mud, from which they digest algae, diatoms and other organic matter (Raney 1939, Eddy and Underhill 1974, Pflieger 1980).

***4. Movement/Dispersal.*** - No information regarding movement patterns or dispersal ability is available for the western silvery minnow. However, Raney (1939) noted that adult eastern silvery minnows migrated to inshore waters of lakes and larger rivers in the spring to spawn, but it is not clear how far these fish migrated. Similarly, no information is available regarding the ability of the species to disperse and re-colonize new or empty habitats. The fact that the western silvery minnow has likely undergone fairly regular drought conditions in the past and

still persists in the Milk River suggests that it has the ability to disperse short distances into empty habitats that may have temporarily been devoid of water.

## DISTRIBUTION

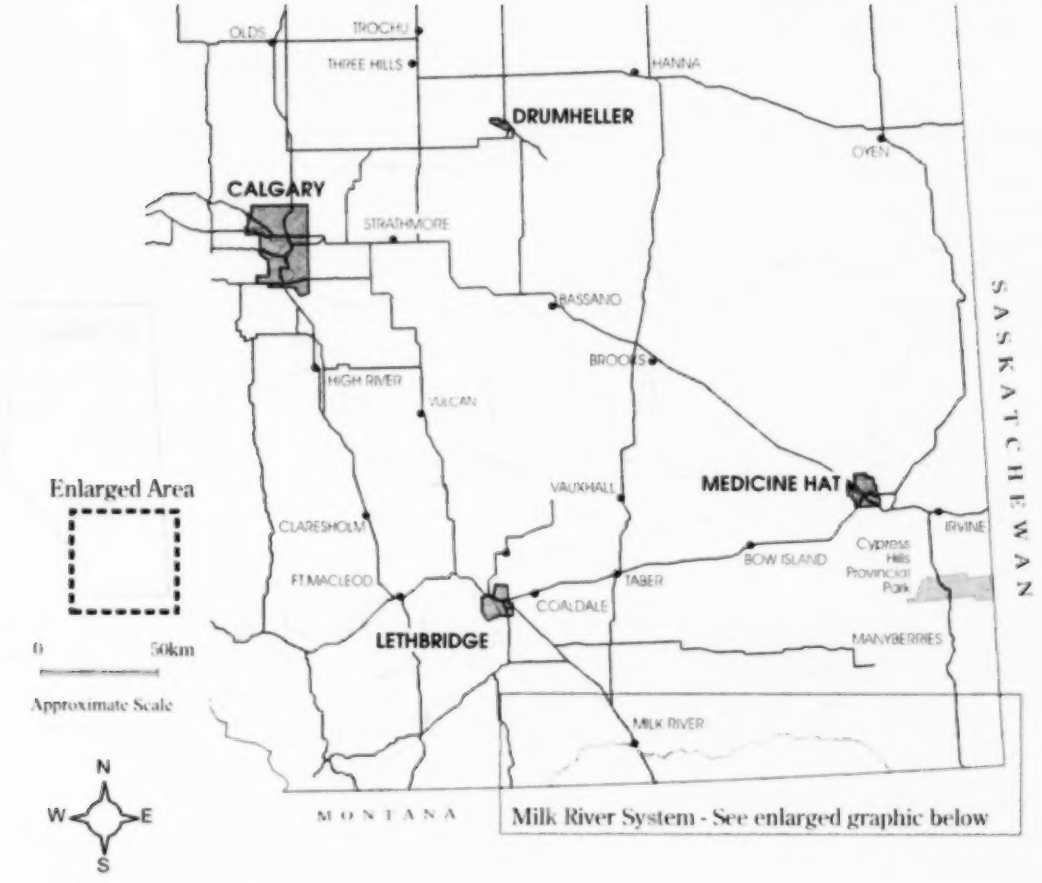
***1. Alberta.*** - The western silvery minnow colonized Alberta after the last glaciation (Late Wisconsinan) when access became available, approximately 13 000 years ago (Nelson and Paetz 1992). Based on present-day distribution patterns, it is believed that western populations of *H. argyritis*, such as those found in the Milk River, moved north from a Missouri refugium rather than a Mississippian one (unlike other silvery minnow species) (Crossman and McAllister 1986).

The only confirmed occurrence of western silvery minnow in Canada is in southern Alberta, specifically in the Milk River system. The Milk River is one of the northernmost tributaries of the Missouri River, and the northernmost extent of western silvery minnow's distribution. It was first collected in the Alberta section of the Milk River in 1961 (see Appendix 3), but the first published occurrence here was documented by Willock (1968). Limited collections have since been made between 1971 and 1979, in 1986 and during more detailed surveys of the Milk River in 2000 and 2001 (See Appendix 3 for details of collections).

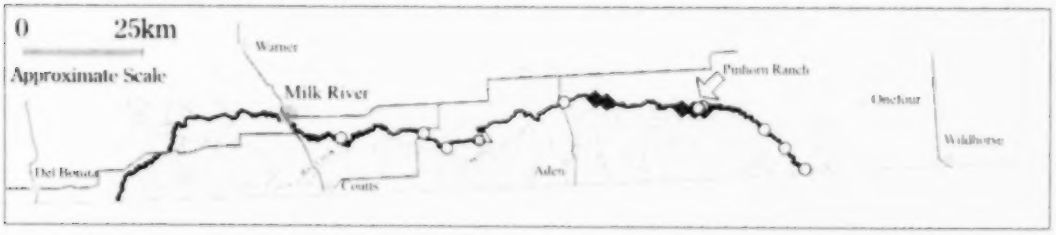
A number of studies have been conducted throughout the Milk River mainstem, the North Milk River and tributaries to the system (Willock 1969b, Clayton and Ash 1980, RL&L 1987, 2002b). All of these studies concluded that the distribution of the western silvery minnow appears to be restricted to the lower Milk River mainstem. This section of the Milk River occurs in the Dry Mixedgrass Natural Subregion of Alberta (Alberta Natural Heritage Information Centre 2002a). The minnow's westernmost occurrence was documented approximately 30 km downstream of the town of Milk River (Willock 1969b) (Figure 1). Recent surveys found silvery minnows to be limited to more downstream sites in the Pinhorn Ranch area of the Milk River mainstem in 2000-2001, and to Deer Creek bridge and Pinhorn Ranch area in 1986 (Figure 1). Earlier studies noted the minnow's presence extended to the United States border (Willock 1969b), but the more recent surveys (RL&L 2002) did not conduct collections this far downstream to confirm its presence here. There is no reason to believe this distribution has changed. A large number of minnows (n=368) were collected by Willock (1969b) from the mouth of the Lost River, a tributary to the lower Milk River, in Montana. However, most recently, this tributary was dry where sampled in Alberta (approximately 30 km upstream of confluence with the Milk River) (RL&L 2001), and it is not known whether the minnow actually uses the tributary or just the mouth. No specimens have been collected from any other tributaries in Alberta, but given the intermittent nature of these small systems, use would be opportunistic at best.

Henderson and Peter (1969) documented a single specimen of western silvery minnow from the South Saskatchewan River within the city limits of Medicine Hat in 1963. However, a series of more recent sampling efforts in 1974-1975 and during 1994-1996 in this area, as well as upstream and downstream of this section, did not detect any additional specimens (W. Roberts, pers. comm.). This specimen is believed to be a spurious account and not representative of a breeding population (W. Roberts, pers. comm.). Its presence is thought to be the result of an accidental release of bait fish (Henderson and Peter 1969) rather than misidentification, because its identification was confirmed by experts in the field (W. Roberts, pers. comm.). However, the possibility of an extremely small population existing here cannot be ruled out (M. Steinhilber, pers. comm.).

There is no information available on the number of subpopulations that exist in the Milk River.




Milk River System Enlarged




Legend

- ○ Pre 1979 data
- △ Clayton and Ash 1980
- ○ RL&L 1987
- ◆ RL&L 2002b

Figure 1. The distribution of western silvery minnow in Alberta (modified from RL&L 2002b). Specific locations correspond to collection sites summarized in Appendix 3. The collection from the South Saskatchewan River listed in Appendix 3 is not shown on this map, because the coordinates were not available.

Habitat fragmentation is at most only temporary, occurring during extreme drought conditions. Although the distribution of western silvery minnows in the lower Milk River appears to be patchy, the patchiness may in part be associated with the difficulties of sampling a very limited population size rather than reflect the true distribution of the species in the river. The potential for gene flow throughout this entire section in most years is high and probably prevents the development of genetically distinct subpopulations. Conservatively, it is likely that Alberta contains only one population in the Milk River (although the status of the minnow in the South Saskatchewan River remains unclear). Given the lack of obvious barriers between the lowest section of the Milk River in Alberta and the section immediately south of the United States border, it is likely that the Alberta population of western silvery minnows is part of a larger genetic population found in Montana. Compared to the surveys conducted in the Canadian portion of the Milk River (see Appendix 3), a significantly larger number of minnows (n=64) were collected in the Milk River a few kilometres on either side of a gauging station in Montana close to the border (station # 06135000, lat. 48° 49' 03", long. 110° 28' 10") (S. Stash, pers. comm.).

In summary, the distribution of the western silvery minnow in Alberta appears to be limited to the lower Milk River, a section approximately 200 km in length, and variable in width, ranging from 0 m in some sections at lowest flows to approximately 20 m at high flows (T. Clayton, pers. comm.). Within that stretch, the area actually occupied by the species is difficult to calculate, given that no studies have conducted surveys along the entire length of the river. The 200 km section of the lower Milk River that contains western silvery minnows represents a relatively small proportion of the total present-day range of this species in North America (Figure 2). Too few data are available to evaluate annual fluctuation in the extent of occurrence within Alberta, but some fluctuation appears to be associated with the variability in water levels. However, there are likely no major changes in extent of occurrence since the western silvery minnow was first documented within the Milk River.

***2. Other Areas.*** - Beyond Alberta, the western silvery minnow is distributed in large, lowland plains streams of the Mississippi River system, extending from the mouth of the Ohio River north to the Missouri River basin and the Milk River in Montana (Pflieger 1980) (Figure 2). It is found in the Mississippi River mainstem only below the mouth of the Missouri River (Burr and Page 1986), and throughout the Missouri River (Cross et al. 1986). Within these systems, distribution appears to be fairly continuous (Pflieger 1980), although the creation of reservoirs and dams has fragmented some sections of rivers. South of the international border, the nearest known population of the western silvery minnow occurs in the Milk River between the border and Fresno Reservoir in Montana (located approximately 80 km downstream of the border) (Stash 2001). Western silvery minnow populations in the Milk River south of the United States border are fragmented by a series of seven impassable irrigation diversions and dams (from Fresno Reservoir downstream to the Vandalia diversion dam in Montana) before the confluence with the Missouri River (Kent Gilge, pers. comm.).

With regards to changes in distribution, Willock (1968) indicated that the loss of the western silvery minnow had occurred throughout extensive areas in the United States, but no specific locations were provided. Trautman (1957) believed that increased turbidity was responsible for the extirpation of eastern silvery minnow in Ohio. These older studies suggest that changes in extent of distribution likely occurred much earlier in the century, but no specific records for western silvery minnow were available.

Figure 2. The distribution of western silvery minnow in North America. From Pflieger (1980), U.S. Fish and Wildlife Service (1995), Houston (1998b), and United States Geological Survey (2001).

## POPULATION SIZE AND TRENDS

***1. Alberta.*** - There is virtually no information available to establish population size or trends (Houston 1998a). Willock (1968) hypothesized that the abundance of western silvery minnow in the upper reaches of the Milk River may have declined in the early 1900s as a result of increased turbidity associated with the channeling of irrigation water into the system. Unfortunately, this decline is only speculative as no data are available from before the 1960s, and it is impossible to estimate to what degree these altered conditions might have affected the size of the population. Although too few data have been collected in the past to accurately estimate the population size, it is clear that since first identified in the early 1960's the western silvery minnow remains a very rare species in the Milk River. The western silvery minnow population in Alberta likely does not exceed a few thousand individuals in a year of average flow; however, their numbers may be significantly lower, depending on intensity and frequency of drought conditions, and time elapsed since the most recent drought. Sampling efforts from the 1960's (Willock 1969b), 1980's (RL&L 1987, Clayton and Ash 1980) and 2000-2002 (RL&L 2001, 2002a, b) consistently found this species to make up a very small portion of the fish species composition (=0.5%) (Table 1).

The most recent surveys permit the comparison of catch-per-unit-effort (CPUE; see Glossary, Appendix 1) data for a single location on the lower Milk River, based on beach seine catches. In fall 1986, CPUE was 0.57 fish/100 $m^2$ (RL&L 1987); whereas in fall 2000, CPUE was 1.22 fish/100 $m^2$, and in fall 2001 CPUE was 4.8 fish/ 100 $m^2$ (RL&L 2002b). The higher value in 2001 likely reflects improved capture efficiency associated with the isolated pools rather than an increase in abundance (RL&L 2002b). Given the recent drought event in the Milk River system, the present abundance of western silvery minnow is unknown but likely reduced. Because the majority of the lower Milk River section used by the minnow was reduced to isolated pools in 2001, the population may have decreased substantially. Surveys on the lower Milk River in fall 2002 will be used to address this issue (T. Clayton, pers. comm.).

***2. Other Areas.*** - The nearest population of western silvery minnow to that in Alberta occurs in the Milk River between the United States border and the Fresno Reservoir in Montana. Here, the minnow comprises a significantly larger proportion of the fish community than in Alberta, making up 5.86% of the total fish species composition, second only to the flathead chub (Stash 2001). However, it is unclear how the extreme drought conditions and lack of water in this section during fall and winter of 2001-2002 may have affected the population size (K. Gilge, pers. comm.). From a broader perspective, the western silvery minnow is common throughout the Missouri River, where it is a dominant species in the lower reaches (Cross et al. 1986). In general, Pflieger (1980) stated that where they still occur in the United States, the western silvery minnow is considered common. Unfortunately, no specific information was available to establish population sizes or trends for any of these areas (Houston 1998a).

## LIMITING FACTORS

***1. Alberta.*** - Potential rearing, feeding and even overwintering habitats in the lower section of the Milk River appear to be widely available in most years (RL&L 2002b). Therefore, other factors are believed to be influencing the distribution and abundance of the western silvery minnow in Alberta (RL&L 2002b). The Milk River in Alberta is situated in a geographic region that is subject to extreme yearly and seasonal climatic fluctuations. This variability, in addition to anthropogenic influences on the river system, may be responsible for limiting the distribution and abundance of this species.

Table 1. Comparison of western silvery minnow sample sizes and percent species composition of total catch* from the lower Milk River mainstem and creek mouths over time.

| Year | Season | Sample Size | % Total Composition | Reference |
|---|---|---|---|---|
| 2001 | October | 35 | 0.5 | RL&L 2002b |
| 2001 | July | 4 | 0.4 | RL&L 2002b |
| 2000 | October | 2 | 0.1 | RL&L 2001 |
| 1986 | July-October | 10 | <0.1 | RL&L 1987 |
| 1980 | November | 2 | 0.4 | Clayton and Ash 1980 |
| 1966 | June | 3 | <0.1 | Willock 1969b |

*Note that in most cases, beach seines were used for sampling. Other techniques proved mainly ineffective at capturing this species because of sandy substrate and turbidity.

The Milk River is highly susceptible to heavy silt load associated with continuous erosion of the surrounding grasslands and river banks (Willock 1968). Willock (1968) stated that the increased rate of erosion associated with channelization for irrigation and overgrazing could result in the decline or extirpation of the western silvery minnow from its Canadian range, and may be the reason for its extirpation in areas in the United States. Similarly, Trautman (1957) believed that the w stern silvery minnow, like its eastern counterpart, has a limited tolerance for suspended sediment. However, given its apparent preference for highly turbid waters, it is unlikely that the high sediment load in the Milk River is the primary limiting factor for western silvery minnow distribution in Alberta. Nonetheless, the silt content and/or channel type does appear to be correlated with differences in abundance in Alberta versus immediately downstream of the international border. Upstream of the border, where minnow abundance is relatively low (=0.5% of total composition), the lower Milk River is characterized by a single meandering channel and channel banks with a silt/clay content of 65% (Simpson and Smith 2000); however, immediately downstream of the border, where the minnow is common, the river is more characteristic of the braided, shifting sand-bottomed Missouri River. Here, the silt/clay content is significantly lower at 18% (Simpson and Smith 2000), and minnow abundance is much greater (>5% of total composition). Possibly, extreme levels of silt affect reproductive success (T. Clayton, pers. comm.). However, it is not clear if there is a point at which silt load in the water becomes detrimental to the western silvery minnow. In addition, there is no information available to compare silt loads over time for the Milk River (T. Clayton, pers. comm.).

The highly variable water volume is likely the primary limiting factor affecting survival of western silvery minnow in the Milk River. Specifically, the combination of drought, canal operation and water removal in the southern part

of Alberta is probably the biggest potential factor that could lead to the extirpation of western silvery minnow. Southern Alberta is susceptible to extreme drought conditions during the summer. Naturally low flows at this time may be exacerbated by the seasonal operation of the St. Mary Canal and by water removal for irrigation, mainly in the vicinity of the town of Milk River (T. Clayton, pers. comm.). For example, the mean monthly discharge during August 2000 was approximately the same as average historic value since 1910 (RL&L 2002b). However, the mean discharge during October and December 2000 was 11% and 20% of historic values, respectively (RL&L 2001). In 2001, the situation was even worse with mean discharge in August, October and December being approximately 50%, 7% and 6% of the average, respectively (RL&L 2002b). In particular, such low flows could severely limit the availability of overwintering habitat (RL&L 2001), greatly reducing overwintering survival. In the late fall and winter of 2001/2002, the lower Milk River, where most western silvery minnows were previously observed, dried up completely except for a series of isolated pools (RL&L 2002a). Ten of the 32 isolated pools in this section were evaluated in March 2002 for habitat quality and fish presence. Although dissolved oxygen levels were not limiting, water depth was very limiting, and no western silvery minnows were observed (RL&L 2002b). The severity of the drought conditions observed in 2001 is not uncommon for southern Alberta (T. Clayton, pers. comm.; see also historical discharge for the Milk River in Fig. 3.9 of RL&L 2002b). The western silvery minnow has persisted under similar drought conditions in the past, although the frequency of such conditions may prevent the population from expanding beyond the low abundance levels that have been observed. What makes 2001 somewhat more significant is the unusually high temperatures that accompanied the drought during the summer months; all fish species, including the minnow, were therefore at increased risk of prolonged exposure to high water temperatures in low water levels (T. Clayton, pers. comm.).

Extended periods of isolation in pools during the fall and winter months, when turbidity is much reduced, increases the minnow's vulnerability to predation by other fish species including the sauger (*Stizostedion canadense*) (T. Clayton, pers. comm.). Similarly, extremely low water levels during the summer months could result in dangerously low oxygen levels, elevated water temperatures and reduced turbidity, exposing the fish to aquatic and terrestrial predators. These conditions may be exacerbated by repair work and maintenance of the St. Mary Canal that result in temporary or premature closure of the diversion (T. Clayton, pers. comm.). For example, the canal was closed in mid-August rather than mid-September in 2001 because of repair work (T. Clayton, pers. comm.), exacerbating the conditions associated with low water levels.

***2. Other Areas.*** - Elsewhere in the Great Plains, modifications to habitat, particularly those associated with irrigation, have become a serious limiting factor for the western silvery minnow (Cross et al. 1986). Impoundments have probably had the greatest cumulative effects on fish fauna of the western Mississippi Basin, including *H. argyritis* (Cross et al. 1986). These impoundments alter habitat type, stimulate introductions of exotic species (see Glossary, Appendix 1) and alter flow regimes, sediment loads and microbiota (small, often microscopic organisms), resulting in streams that are generally narrower, less turbid, less subject to discharge and temperature variations (Cross et al. 1986) and less productive. Although these changes to streams have resulted in increased diversity of some prairie fish species, several species have declined, including the western silvery minnow, even though they have adapted to shallow sandy streams with widely fluctuating flows, high turbidity and extreme summer temperatures (Cross et al. 1986). Such species that were once abundant and widespread are now out-competed by pelagic planktivores (see

Glossary, Appendix 1) and sight-feeding carnivores, including introduced salmonids (Cross et al. 1986).

Increased turbidity and the loss of aquatic vegetation and organic matter as a result of siltation may also be responsible for the loss of western silvery minnow populations in extensive areas in the United States (Willock 1968). Finally, the greatest threats listed for the western silvery minnow in North Dakota are non-point source pollution, water depletion from irrigation, degradation of riparian areas, and mainstem impoundments affecting natural flow regimes (United States Geological Survey 2002).

## STATUS DESIGNATIONS*

***1. Alberta.*** - The western silvery minnow is currently ranked as "May be At Risk", according to *The General Status of Alberta Wild Species 2000* (Alberta Sustainable Resource Development 2001). The Alberta Natural Heritage Information Centre (2002b) tracks provincial and global rankings. Provincially, the western silvery minnow is ranked as "S1" (as of April 2000), which is the highest "S" rank.

***2. Other Areas.*** - The western silvery minnow was first designated by COSEWIC as "Vulnerable" (equivalent to the current designation of "Threatened") in April 1997. The national ranking for the United States is N4 (as of August 28, 1998) (NatureServe Explorer 2001). In the United States, western silvery minnow was formerly considered a candidate for the federal rare and endangered species list, but as of February 28, 1996 was removed from this list, although it remains a "species of management concern." The western silvery minnow is ranked "S1" in Iowa, "S2" in Wyoming, Kansas, Missouri and Illinois, "S4" or "S5" in Montana, Nebraska and South Dakota, and is unranked in North Dakota (NatureServe Explorer 2001). Globally, the Nature Conservancy gave this species a status of "G4" (as of November 1998).

*See Appendix 2 for definitions of the status designations referred to in this section.

## RECENT MANAGEMENT IN ALBERTA

No specific management for western silvery minnow has occurred in Alberta. However, the extremely limited distribution of this species in the Milk River and its vulnerability to water conditions prompted the Fish and Wildlife Division of Alberta Sustainable Resource Development to commission recent and ongoing surveys in the Milk River (2000 to present; see Addendum). The purpose of this work was to help determine the status of the western silvery minnow in Alberta and to provide recommendations with regards to protection. These recommendations include the maintenance of monitoring studies on a regular basis at specific index sites to track abundance, and more detailed studies on the distribution, abundance and habitat preferences of the western silvery minnow (RL&L 2002b).

It should be noted that to date, no minimum flows to address fisheries requirements have been established for the Milk River (T. Clayton, pers. comm.). Such guidelines would ensure that adequate refugia are available for the western silvery minnow at most times. The identification and protection of critical habitat requirements for juvenile and adult western silvery minnow in the lower Milk River is crucial to the continued existence of this rare species in Alberta.

## SYNTHESIS

The western silvery minnow is a unique species in Alberta as it is one of the two emigrants (the other being stonecat, *Noturus flavus*) from the Missouri glacial refugium to disperse no further north than the Milk River. The population of western silvery minnow in the lower Milk River mainstem appears to be extremely small,

occurring only sporadically throughout the area from the international border to downstream of the town of Milk River. Use of the tributaries is unknown, but at best only temporary, depending on adequate water flows. This population, and therefore the species' presence in Alberta (and Canada), is extremely vulnerable to habitat perturbations in the Milk River system associated with the operation of the St. Mary Canal and water withdrawal for irrigation, as well as the severe drought conditions that this region regularly experiences. In particular, the survival of western silvery minnow is likely limited by low water flows affecting overwintering habitat availability and the lack of refugia in the lower Milk River. The combination of severe drought and water removal in southern Alberta is probably the biggest potential threat to the western silvery minnow in Alberta.

At present, very little is understood about the biology, life history, population size or dynamics of the one confirmed western silvery minnow population in Alberta. Recent studies on the Milk River in 2000-2001 suggest that its abundance has not changed since the species was first documented in the 1960s, although this conclusion may change, depending on the results of 2002 surveys. All studies have concluded that this species is extremely low in abundance, with an extremely limited range of distribution. The western silvery minnow in Alberta requires protection to ensure that some refugia are available, particularly during the winter.

The first step in the protection of western silvery minnow must be to confirm its status in the Milk River since the drought during 2001-2002. This work is currently underway (see Addendum). Future studies should focus on better defining the life history, biology and habitat requirements (especially spawning habitat) of western silvery minnow. Long-term monitoring studies should be established using index sites to track trends in population size. In addition, it is unclear how siltation and turbidity affect the species in the Milk River, although it has been suggested that increased levels associated within irrigation water diversions may limit abundance and distribution. Finally, it is essential that Montana and Alberta work collaboratively to put biologically meaningful minimum water flows in place for the Milk River to ensure that refugia are always available to the western silvery minnow.

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**Appendix 1. Glossary of terms.**

***Catch-per-unit-effort (CPUE)*** – A standard fisheries term that quantifies fish abundance in terms of effort applied to catch fish using a particular sampling methodology

***Caudal peduncle*** – The portion of the body between the end of the anal fin (between pelvic and tail fins) and the base of the tail fin (Nelson and Paetz 1992)

***Confluence*** – Where the mouth of a tributary joins the mainstem

***Exotic species*** – Species that are non-native or non-indigenous to an ecosystem, and have usually been released into these systems through human activities

***Flat and run habitats*** - Flat habitat is a depositional area of channel characterized by low current velocities and no turbulence, uniform in nature and often predominantly sand/silt substrate. Run habitat is a section of channel characterized by moderate to high current velocities and relatively unbroken water surface (from RL&L 2002b).

***Fork length*** – The straight length distance from the tip of the snout laterally to the central part of the margin of the tail fin (Nelson and Paetz 1992)

***Pelagic planktivores*** – Refers to species of fish that occur within the water column (not on the bottom) and usually rely on sight to capture plankton (small plant and invertebrate organisms)

***Refugium (glacial)*** – Ice-free areas that provided habitat for species during glacial periods

***Subterminal mouth*** – The upper jaw overhangs the lower jaw

***Total length*** – The straight line distance from the tip of the snout to the extreme end of the tail fin (Nelson and Paetz 1992)

## APPENDIX 2. Definitions of selected legal and protective designations.

### A. The General Status of Alberta Wild Species 2000 (after Alberta Sustainable Resource Development 2001)

| 2000 Rank | 1996 Rank | Definitions |
|---|---|---|
| At Risk | Red | Any species known to be "At Risk" after formal detailed status assessment and designation as "Endangered" or "Threatened" in Alberta. |
| May Be At Risk | Blue | Any species that may be at risk of extinction or extirpation, and is therefore a candidate for detailed risk assessment. |
| Sensitive | Yellow | Any species that is not at risk of extinction or extirpation but may require special attention or protection to prevent it from becoming at risk. |
| Secure | Green | Any species that is not "At Risk", "May Be At Risk", or "Sensitive". |
| Undetermined | Status Undetermined | Any species for which insufficient information, knowledge or data is available to reliably evaluate its general status. |
| Not Assessed | n/a | Any species known or believed to be present but which has not yet been evaluated. |
| Exotic/Alien | n/a | Any species that has been introduced as a result of human activities. |
| Extirpated/Extinct | n/a | Any species no longer thought to be present in Alberta ("Extirpated") or no longer believed to be present anywhere in the world ("Extinct"). |
| Accidental/Vagrant | n/a | Any species occurring infrequently and unpredictably in Alberta, i.e., outside their usual range. |

### B. Alberta Wildlife Act/Regulation

Species designated as "Endangered" under Alberta's *Wildlife Act* include those listed as "Endangered" or "Threatened" in the Wildlife Regulation.

| | |
|---|---|
| Endangered | A species facing imminent extirpation or extinction. |
| Threatened | A species that is likely to become endangered if limiting factors are not reversed. |

### C. Committee on the Status of Endangered Wildlife in Canada (after COSEWIC 2002)

| | |
|---|---|
| Extinct | A species that no longer exists. |
| Extirpated | A species that no longer exists in the wild in Canada, but occurs elsewhere. |
| Endangered | A species facing imminent extirpation or extinction. |
| Threatened | A species that is likely to become endangered if limiting factors are not reversed. |
| Special Concern | A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events. |
| Not at Risk | A species that has been evaluated and found to be not at risk. |
| Data Deficient | A species for which there is insufficient scientific information to support status designation. |

**D. Heritage Status Ranks: Global (G), National (N), Sub-National (S) (after Alberta Natural Heritage Information Centre 2002c)**

| | |
|---|---|
| G1/N1/S1 | 5 or fewer occurrences or only a few remaining individuals. May be especially vulnerable to extirpation because of some factor of its biology. |
| G2/N2/S2 | 6-20 or fewer occurrences or with many individuals in fewer locations. May be especially vulnerable to extirpation because of some factor of its biology. |
| G3/N3/S3 | 21-100 occurrences, may be rare and local throughout it's range, or in a restricted range (may be abundant in some locations). May be susceptible to extirpation because of large-scale disturbances. |
| G4/N4/S4 | Typically >100 occurrences. Apparently secure. |
| G5/N5/S5 | Typically >100 occurrences. Demonstrably secure. |
| GX/NX/SX | Believed to be extinct or extirpated, historical records only. |
| GH/NH/SH | Historically known, may be relocated in future. |

**E. United States Endangered Species Act (after National Research Council 1995)**

| | |
|---|---|
| Endangered | Any species which is in danger of extinction throughout all or a significant portion of its range. |
| Threatened | Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. |

**APPENDIX 3. Specific locations of all recorded western silvery minnow collected in Alberta.**

| System | Directions | Coordinates | Date Collected | Reference [1] | Sample Size |
|---|---|---|---|---|---|
| Milk R. | NA | 8-2-6-W4 | 13-May-61 | UAMZ 5320 | 2 |
| South Saskatchewan R. | near Medicine Hat | NA | May-June 63 | Henderson and Peter 1969 | 1 |
| Milk R. | 27.4 km E, 4.8 km S of the Town of Milk River at Weir Bridge | S.8, Twp.2, R.13 | 14-Jun-66 | Willock 1969b | 1 |
| Milk R. | 12.9 km N, 1.6 km W of Aden below Aden Bridge | S.20, Twp. 2, R.10 | 4-Sep-66 | Willock 1969b | 2 |
| Lost R.[2] (tributary to Milk R.) | Mouth of Lost R. Coulee 8 km N and 12.9 km W of Simpson, Montana | NA | 11-Jun-67 | Willock 1969b | 368 |
| Milk R. | 6.4 km E of Writing-on-Stone Park | NA | 12-May-71 | UAMZ 2846 | 2 |
| Milk R. | 35.4 km S, 4.8 km W of Orion | NA | 30-May-72 | UAMZ 3335 | 1 |
| Milk R. | 35.4 km S, 4.8 km W of Orion | NA | 30-May-72 | UAMZ 3338 | 21 |
| Milk R. | 35.4 km S, 4.8 km W of Orion | NA | 30-May-72 | UAMZ 3339 | 21 |
| Milk R. | 37 km S, 3.2 km W of Orion | NA | 28-Apr-73 | UAMZ 3241 | 1 |
| Milk R. | 1.6 km W of Deer Cr. | NA | 28-Apr-73 | UAMZ 3244 | 1 |
| Milk R. | 27.4 km W of Wildhorse | NA | 16-May-73 | UAMZ 3234 | 5 |
| Milk R. | 1.6 km W of Deer Cr. | NA | 23-Jul-74 | UAMZ 3548 | 26 |
| Milk R. | 4.8 km S of Crofton at Hwy 880 crossing | NA | 30-Jun-76 | UAMZ 3838 | 2 |
| Milk R. | Deer Cr. Bridge 125.3 km upstream of border | 49° 05' 11.51" N 111° 32' 54.26" W | 20-Nov-79 | Clayton and Ash 1980 | 2 |

[1] UAMZ = University of Alberta Museum of Zoology specimen record number.

[2] Only location from outside of Alberta included in this list (but not on the map). Significant because of the large sample size in comparison to the other sites and its proximity to Alberta (approximately 17 km downstream of the border).

| System | Directions | Coordinates | Date Collected | Reference [1] | Sample Size |
|---|---|---|---|---|---|
| Milk R. | Pinhorn Ranch 56.4 - 51.8 km upstream of border | 49° 07' 29.55" N 110° 54' 15.02" W | 3-Jul-86 | RL&L 1987 | 2 |
| Milk R. | Pinhorn Ranch 56.4 - 51.8 km upstream of border | 49° 07' 29.55" N 110° 54' 15.02" W | 29-Aug-86 | RL&L 1987 | 4 |
| Milk R. | Pinhorn Ranch 56.4 - 51.8 km upstream of border | 49° 07' 29.55" N 110° 54' 15.02" W | 20-Oct-86 | RL&L 1987 | 2 |
| Milk R. | Deer Cr. Bridge 129.0 - 124.5 km upstream of border | 49° 05' 03.36" N 111° 34' 52.25" W | 27-Aug-86 | RL&L 1987 | 1 |
| Milk R. | Pinhorn Ranch 56.4 - 56.2 km upstream of border | 49° 07' 29.55" N 110° 54' 15.02" W | 20-Oct-86 | RL&L 1987 | 1 |
| Milk R. | Pinhorn Ranch | 49° 06' 21.93" N 110° 54' 18.53" W | 21-Oct-00 | RL&L 2002b | 2 |
| Milk R. | Pinhorn Ranch | 49° 07' 22.78" N 110° 54'13.58" W | 19-Oct-01 | RL&L 2002b | 13 |
| Milk R. | Pinhorn Ranch | 49° 07'16.72" N 110° 55' 06.23" W | 19-Oct-01 | RL&L 2002b | 2 |
| Milk R. | Pinhorn Ranch | 49° 07' 25.65" N 110° 57' 35.08" W | 20-Jul-01 | RL&L 2002b | 1 |
| Milk R. | Pinhorn Ranch | 49° 07' 29.08" N 110° 55' 23.34" W | 19-Oct-01 | RL&L 2002b | 1 |
| Milk R. | Pinhorn Ranch | 49° 07' 25.20" N 110° 54' 46.44" W | 19-Oct-01 | RL&L 2002b | 11 |
| Milk R. | Ross Ranch | 49° 08' 59.28" N 111° 11' 44.62" W | 20-Oct-01 | RL&L 2002b | 6 |
| Milk R. | Ross Ranch | 49° 08' 17.18" N 111° 09' 39.04" W | 20-Oct-01 | RL&L 2002b | 1 |

**Addendum to Status of the Western Silvery Minnow (*Hybognathus argyritis*) in Alberta:**

**Summary of data collected in fall 2002**

The schedule for the completion of the main report *Status of the Western Silvery Minnow (Hybognathus argyritis) in Alberta* did not permit the inclusion of the most recent data collected in the fall of 2002 on the Milk River. However, the results of these collections have implications to the status evaluation of the western silvery minnow, and are discussed here.

In October 2002, additional surveys of fish and fish habitat were conducted on the Milk River (P&E 2002). The purpose of these surveys was to sample areas of the Milk River not previously sampled in 2000-2001 (R.L.&L. 2001, 2002a, 2002b), particularly the most downstream section of the Milk River in Alberta. Given the severe drought conditions of late summer and fall 2001, these additional surveys were also conducted to determine the post-drought status of fish species of interest, especially the western silvery minnow. The surveys were restricted to a narrow sampling window of October 22-27, 2002, by high water conditions and the onset of winter. Sampling was conducted primarily in the stretch of river 57 km downstream of Pinhorn Ranch (see attached map), and included 29 sites (24 beach-seined and 5 electro-fished) located approximately every 2 km to the international border. In addition, a secondary section approximately 40 km in length above the Town of Milk River was evaluated at 6 sites (1 beach-seined and 5 electro-fished). Surveys employed sampling techniques similar to those used in 2000-2001 by RL&L.

The western silvery minnow was the second most common fish species after flathead chub (*Platygobio gracilis*) in the section downstream of Pinhorn Ranch. The minnow made up 43.7% of the total composition of species captured, and a total of 63 specimens were collected. All specimens were collected via beach seine and were found at nine of the 24 beach seine sites (see attached map). The overall catch rate or CPUE was 0.62 fish/100 $m^2$ and ranged from 0.22 to 5.78 fish/100 $m^2$. No minnows were captured in the upstream section of river above the Town of Milk River.

The number of western silvery minnows captured during October 2002 is higher than any previous collection on the Milk River. It is unlikely that this value reflects a true increase in abundance compared to previous years. In part, this high value is likely the result of the improved fishing efficiency of the survey crew, who were able to apply the knowledge gained during 2000 and 2001. In addition, the comparatively high number of western silvery minnows likely reflects the type of habitat available in the downstream section of the Milk River. Sand was the predominant substrate in the downstream section (81%), whereas larger substrates were more common upstream of the Town of Milk River where sand only comprised 11% of the total substrate composition. In addition, turbidity was higher downstream while silt was negligible at most sites. The results of this most recent work are similar to the findings of Stash (2001) who conducted surveys of the Milk River downstream of the international border. He also noted that western silvery minnow had the second highest level of abundance after flathead chub and collected a total of 64 minnows between the border and the Fresno Reservoir.

In summary, these results indicate that the western silvery minnow is capable of finding refugia in the lower Milk River during times of severe drought conditions such as those observed in 2001. Furthermore, the lowest section of the Milk River downstream of Pinhorn Ranch appears to provide the best habitat for the minnow. This section is probably the most similar in habitat type to the section immediately downstream of the border, where higher numbers of western silvery minnow have been recorded.

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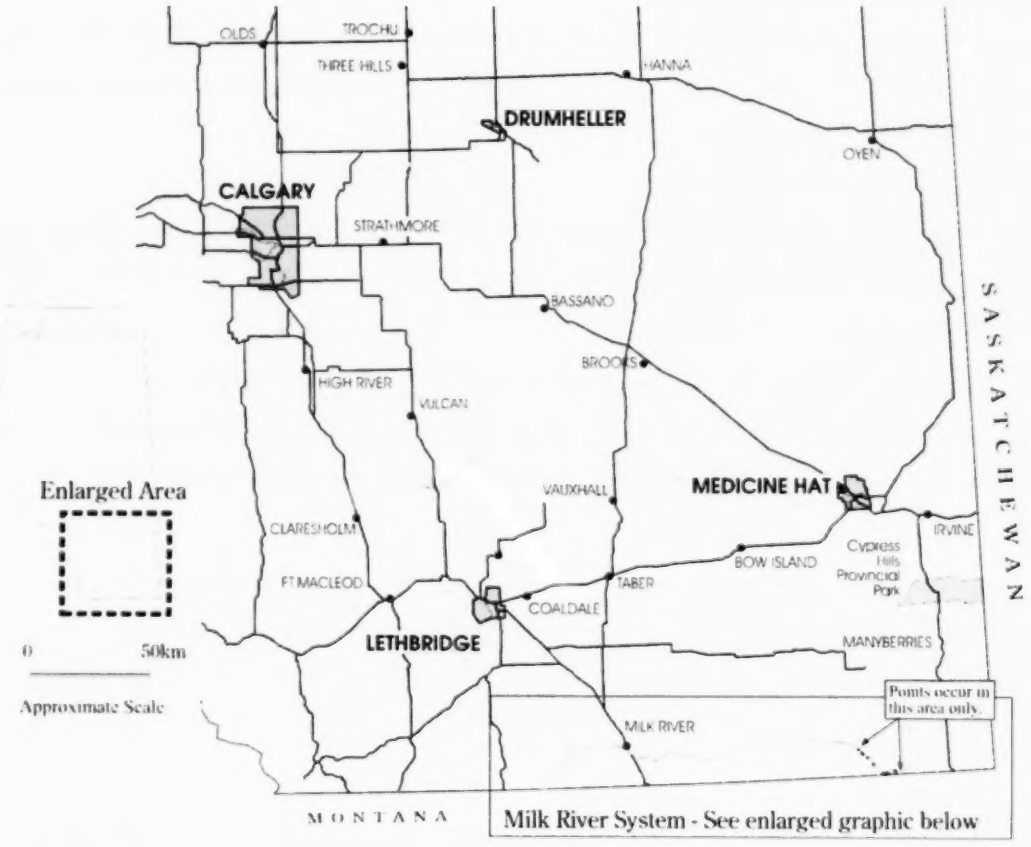
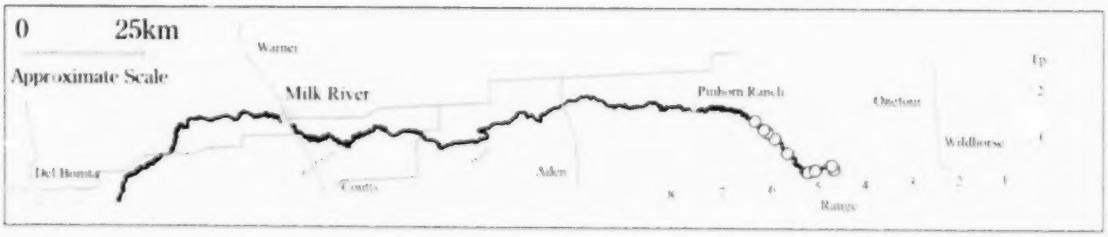



## Milk River System Enlarged




Legend

○ P&E 2002

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